

TABLE IV.

Soil C + 10 grams Starch.
Original N. = .088 per cent.

Experiment No.	Percentage of Nitrogen.	Increase or Decrease.
4	.121	+ .033
5	.146	+ .058
6	.135	+ .047
7	.142	+ .054

From these experiments it would appear that there is a decided increase of nitrogen when the seed is inoculated with the nitro-culture; further, the increase is greater when sulphate of potash and superphosphate are added to the soil.

Except in the case of peaty soil (Table II), and when combined carbon was added (Table IV), there does not appear to be any special increase of nitrogen by inoculating the soil; and from the results presented in Table II, experiment 5, it is probable that the cellulose in the soil-humus is utilised to promote the growth of the organism and the increase of nitrogen.

The experiments presented here indicate that to a certain extent nitro-culture can be utilised to assist the replacement of the nitrogen removed by crops from the soil.

For permission to publish this paper I have to express my thanks to the Management of the Christchurch Meat Company (Limited), in whose laboratory most of the work was carried out.

ART. IX.—*Notes on New Zealand Echinoderms; with Description of a New Species.*

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Communicated by A. Hamilton, Director Colonial Museum.

[*Read before the Wellington Philosophical Society, 1st August, 1906.*]

THESE notes will serve to clear up some points which were doubtful at the time when my "List of New Zealand Echinoderms" was published (Proc. Linn. Soc. N.S.W., 1898, p. 305); to describe a new ophiuran discovered by my colleague Mr. Arthur Haylock, who has made a fine collection of New Zealand echinoderms; and to correct several omissions in the "Index Faunæ Novæ-Zelandiæ."

Although it is stated in the preface to the "Index" that I revised the Echinoidea, star-fishes, and Hydrozoa, I am not entirely responsible for the lists of these groups. When the late Captain Hutton was compiling the work, in reply to his request I sent copies of my papers to him, and some notes on the nomenclature of several species, and I offered to revise the lists when compiled, but I did not see them until the book was published.

OPHIUROIDEA.

Ophionereis schayeri.

This species, which is abundant near Wellington, Nelson, and Auckland, is very widely spread. Professor Kirk, of Victoria College, found it at the Chatham Islands; Mr. Haylock obtained specimens at the East Cape and at the Kermadec Islands; Dr. Ludwig has determined specimens from Juan Fernandez as our species (Zool. Record, 1898, Ech., p. 67); this or a very nearly allied form was described by Mr. E. A. Smith in the Proceedings of the Zoological Society, 1877, p. 92, from the Galapagos Islands, under the name *Ophionereis albamaculata*; and it occurs freely on the eastern coast of Australia. This is one of the two New Zealand littoral ophiurans which extend northwards into the Indo-Pacific region, the other being *Ophiomyxa australis*. I have found young specimens on the roots and stems of seaweed (*Lessonia* and *Macrocystis*), and it probably came to New Zealand across the Tasman Sea on floating seaweed. The southern branch of the Pacific Equatorial Current, which strikes the north-eastern coast of Australia and is diverted thence southwards and eastwards across the Tasman Sea, assisted by the prevailing westerly winds, has apparently been the means of adding many species to our littoral marine fauna. Our hydroid fauna especially shows the effect of this commingling of Australian forms with those which are peculiarly New-Zealandian.

The distribution of this sea-star appears to indicate a very great amount of vitality. From New Zealand (probably *via* the Chatham Islands) it has spread right across the South Pacific Ocean and up the western coast of South America in the line of distribution of the great sea-tangle of the Southern Ocean, *Macrocystis pyrifera*, a line of distribution followed by a considerable number of other southern forms, as pointed out by Professor D'Arcy Thompson in the Proc. Roy. Soc. Edin., vol. xxii, p. 313. The holothurian *Colochirus brevidentis* is in the same category if Ludwig's identification of specimens from Juan Fernandez is correct. Professor Kirk also found *Ophiomyxa australis* at the Chatham Islands.

Amphiura elegans.

I have followed Professor Bell in retaining Leach's specific name *elegans* (Catl. Brit. Ech., p. 119), although Lyman preferred that of Delle Chiaje—*squamata* (Chg. Rpts., vol. v, p. 136). This is an exceedingly interesting little species, on account of its remarkable geographical distribution, being widely diffused in the temperate seas of both hemispheres. It occurs freely on seaweed in rock-pools near Wellington, and I found great numbers on seaweed in rock-pools at Gisborne, as noted by me in the Linnean Society's Journal (Zool.), vol. xxvi, p. 191. It also occurs in deeper water among sand and gravel, Mr. H. Suter having dredged up a quantity of specimens in Lyttelton and Akaroa Harbours.

Ophiactis nomentis, n. s.

The disc is roundly subpentagonal in form, somewhat swollen above, constricted above the arms, and the edge thick and rounded between the arms; about 9 mm. in diameter. The arms increase slightly in width to a short distance from the disc and then taper evenly to a fine extremity; they are about 46 mm. in length, and the greatest width is 2 mm. The disc is closely covered above with small, rounded, irregular, imbricating scales, somewhat elongated towards the edge of the disc, armed with small, bluntly pointed, smooth spinelets, thickly placed at the edge of the disc between the arms, and a few scattered irregularly around the radial shields and sometimes towards the middle. The radial shields are seed-of-pear-shaped, 2 mm. long and a little less than 1 mm. wide, separated their whole length by a narrow wedge of small elongated scales. One rounded leaflike mouth-papilla on each side of the base of the mouth-angle. Mouth-shields round, with a very slight peak without. Side mouth-shields triangular with re-enteringly curved sides, meeting or almost meeting within. The teeth are short, stout, and wedgelike, the uppermost one being often rounded and leaflike. The upper arm-plates are transversely oval, much broader than long, covering the whole of the upper part of the arm; some of them are usually split into two or three pieces in adult specimens. The under arm-plates are circular, slightly truncated within. The side arm-plates, which do not meet, bear four short, stout, blunt, divergent arm-spines, and one round, leaflike tentacle-scale. The colour of dried specimens is brownish-grey above, the arms being banded or variegated with darker grey, and yellowish-white beneath. In life the disc is reddish, becoming bright-red towards the edge of the disc between the arms.

A number of specimens were dredged up by Mr. Haylock at Cape Maria van Diemen, between the little island on which the lighthouse stands and the mainland, in about 4 fathoms of water, among seaweed and stones.

Ophiopeza danbyi.

This species is given in the "Index" without a reference. It was described by me in the Linnean Society's Journal (Zool.), vol. xxvi, p. 189 (1897), from a specimen collected by Mr. Danby at the Kermadecs, which is now in the Canterbury Museum.

A number of echinoderms are given in the "Index" which are not in my "List." The reason of this is that Captain Hutton included the species found at the Kermadec Islands and "Challenger" Stations Nos. 170 and 170A. These may be included in our fauna, as the Kermadecs are part of this colony, and their land fauna and flora are essentially New-Zealandian.

ASTEROIDEA.

Gnathaster miliaris.

1846. *Astrogonium miliare*, Gray. Proc. Zool. Soc., p. 80.
 1866. " " " Synopsis of Starfish, p. 10.
 1872. *Pentaceros rugosus*, Hutton. Proc. Zool. Soc., p. 812.
 1872. *Astrogonium rugosum*, Hutton. Cat. Ech. N.Z., p. 7.
 1876. *Pentagonaster miliaris*, Perrier. Révis. Stell. Mus., p. 220.
 1878. " " " Archiv. Mus. Hist. Nat.,
 2^e série, vol. 1, p. 84.
 1889. *Gnathaster miliaris*, Sladen. Chger. Rpts., vol. xxx,
 pp. 286, 750.
 1897. *Gnathaster rugosus*, Farquhar. Jrn. Linn. Soc. (Zool.),
 vol. xxvi, p. 194.

Having compared Gray's description and figure and Hutton's description of this species, and of his supposed new species (*N. rugosus*) with Perrier's original description of *Goniodon dilatatus*, and with Hutton's type specimens in the Colonial Museum, I have come to the conclusion that Hutton's *N. rugosus* is *N. miliaris*, Gray; and the specimens identified by Hutton as Gray's species are specimens of Perrier's *Goniodon dilatatus*. The synonymy of Gray's species *G. miliaris* will therefore stand as above.

Goniodon dilatatus.

1872. *Astrogonium miliare*, Hutton (non Gray). Cat. Ech. N.Z., p. 7.

1876. *Pentagonaster dilatatus*, Perrier. Archiv. Zool. Expér., vol. v, p. 33.
1889. *Gnathaster dilatatus*, Sladen. Chger. Rpts., vol. xxx, pp. 286, 750.
1894. *Goniodon dilatatus*, Perrier. Stellérides du Travailleur, p. 244.
1901. *Goniodon dilatatus*, Lorient. Notes pour servir à l'Étude des Echinodermes, ix, p. 43.

My late friend Mr. A. Reischek kindly sent a copy of Perrier's original description of this species to me, which may not be accessible to New Zealand naturalists. It runs thus: "Espèce remarquable par sa forme rappelant un peu celle du *Pentagonaster pulchellus*, bien que les plaques marginales soient disposée tout autrement. Le corps est plat, les bras courts, larges, dilatés au sommet en forme de spatule, et terminées par un bord arrondi. $R=2r$, $d=90$ millimètres. Les deux faces dorsale et ventrale sont uniformément couvertes de granules assez gros et bien distincts les uns des autres. L'ensemble des granules correspondant à chaque ossicule dorsal est nettement séparé des granules voisins, de sorte que les ossicules sont parfaitement distincts les uns des autres; sur la face ventrale, au contraire, il est difficile de distinguer les limites des ossicules squelettiques. Les plaques marginales augmentent graduellement de largeur depuis le sommet de l'arc interbrachial jusque vers le sommet des bras, les dernières seules diminuant de nouveau. La longueur de toutes ces plaques demeure au contraire sensiblement constante. C'est à l'élargissement graduel des plaques marginales qu'est due la form spatulée des bras; l'aire limitée par les plaques, qui sont au nombre de dix-huit, présente comme d'habitude la forme d'un pentagone à côtés concaves. La plaque madréporique est grande et subcentrale. Sur la face ventrale les piquants ambulacraires sont disposés sur trois rangs dont le niveau supérieur dépasse à peine celui de la granulation générale. Les piquants du premier et du seconde rang sont un peu plus gros que ceux du troisième, dont les dimensions transversales sont identiques à celles des granules ventraux."

Asteropsis imperialis.

This species is given in the "Index" without a reference, and wrongly spelt "*Asterospis*." It was described by me in the Linnean Society's Journal (Zool.), vol. xxvi, p. 193. The unique type specimen, which is from the Kermadecs, is in the Canterbury Museum.

Asterias rodolphi.

This Kermadec species is also given in the "Index" without a reference. A few notes were added by me in the Linnean Society's Journal (Zool.), vol. xxvi, p. 192, to M. Perrier's brief original description, which runs thus: "Very like *A. gracialis*, L., from which it differs chiefly in the number of rays, which is seven, and the position of the ventral spines near the ambulacral spines, which form a triple and not a double series as in the European species": Ann. Mag. Nat. Hist., ser 4, vol. xvii, p. 34 (1876). The type, which is in the British Museum, was collected by Macgillivray during the voyage of H.M.S. "Herald" in 1854.

Cribrella ornata.

Professor H. B. Kirk found this species in abundance at the Chatham Islands. He also observed *Asterias calamaria* and *Asterias scabra* at the same place.

ECHINOIDEA.

Echinobrissus recens.

This extremely interesting little echinoid occurs in Tasman Bay; specimens may be found on the beach at "The Sands," near Richmond, after northerly gales. It also occurs pretty freely in the channel at the entrance of Port Nicholson. Mr. Haylock has collected a good many specimens on the beach between Day's Bay and Pencarrow Light, some of them being quite fresh with the spines on. The spines on the abactinal surface are short, slightly tapering, with rounded tips, and longitudinally striated, 1.6 mm. long: those on the actinal surface are longer and finer, the longest, 3.5 mm., being near the mouth. There is a specimen in the Canterbury Museum from the Chatham Islands, and one from Stephen Island. It also occurs in Foveaux Strait.

The genus *Echinobrissus* attained its maximum development in the later Jurassic and early Cretaceous periods, when its forms were numerous and widely diffused. Two species occur in the Australian Tertiaries, and one (*E. papillosus*) in the New Zealand Eocene. If this species occurs in Madagascar, as stated by Agassiz in the "Revision," its distribution is not so remarkable as would appear at first sight, for it is evidently a very old form, and in far distant times—probably before the Cretaceous—Madagascar was much nearer to New Zealand zoologically than it is now. This is shown by the relationship

between the extinct *Dinornithidæ* of New Zealand and the extinct *Æpiornithidæ* of Madagascar. Our fern-bird belongs to a genus (*Sphenæacus*) found only in New Zealand and South Africa, with a near relation in Madagascar; and the beetle *Sternaulax* and the marine shell *Littorina mauritiana* occur in New Zealand and Madagascar, the latter being also found in Australia. (See Introduction to the Index Faunæ N.Z., p. 6.)

Centrostephanus rogersii.

Strongylocentrotus erythrogrammus.

New Zealand specimens of both these species are in the Colonial Museum at Wellington, as noted by me in the Linnean Society's Journal (Zool.), vol. xxvi, p. 189. These are omitted from the "Index," although *Strongylocentrotus tuberculatus*, which is noted as a New Zealand form on the same page, is retained. *C. rogersii* ranges from New Caledonia to Tasmania and New Zealand, and *S. erythrogrammus* occupies the same area, with extensions to Japan and Chili. *S. tuberculatus* was found at the Kermadecs by Mr. Haylock.

Sphærechinus australe.

This species, which is given in my "List" and omitted from the "Index," occurs in Australia, Tasmania, Mauritius, and the Society Islands. It is recorded by Agassiz as from New Zealand, and is one which we might expect to find here; as, however, it is not known to New Zealand naturalists, it may be omitted from our list, at any rate for the present.

Holopneustes inflatus.

I gave this species in my "List" on the authority of Mr. Agassiz (Rev. Ech., pp. 136, 483; and Chger. Repts., iii, p. 274), but as it is not known here it may be correctly omitted from the "Index." Dr. Ramsay says, "Three species—*H. inflatus*, *H. porosissimus*, and *H. purpurescens*—are somewhat doubtfully recognised by Agassiz, and without a large series of specimens it is almost impossible to distinguish the varieties: it is quite likely that they all belong to one species. As *Holopneustes* occurs on the east and south coasts of Australia, it is not unlikely to occur in our seas. Some dredging operations have recently, I believe, been carried on in the neighbourhood of Dunedin, and some of the species now omitted from our list may have been rediscovered, but I do not know what echinoderms were obtained.

Echinus margaritaceus.

Peronella rostrata.

Metalia sternalis.

These three species are omitted from the "Index." I included them in my "List" on Mr. Agassiz's authority (Chger. Repts., iii, pp. 274, 275). *Echinus margaritaceus* is widely spread in southern seas, having been found at the Straits of Magellan, Juan Fernandez, Kerguelen Land, and Heard Island, and we may expect to find it in our southern waters; but as it is not known to New Zealand naturalists it may be omitted for the present: *Peronella rostrata* is a Zanzibar form which does not occur here. We have a species of *Peronella*, however, specimens of which are in the Otago Museum, from the West Coast Sounds. Two species of *Peronella* occur in Australian waters, *P. decagonale* and *P. peronii*. The former appears to be confined to the Indo-Pacific region, and the latter ranges from the Philippine Islands to Tasmania. Being unacquainted with these, I cannot identify our species. *Metalia sternalis* is a tropical form, widely diffused in the Indo-Pacific region, and does not, I think, occur in our seas.

Brissopsis luzonica.

I do not know of the occurrence of this species here. It is a tropical form, widely spread in the Indo-Pacific region, and I do not think it belongs to our fauna. It is given in the "Index," although I marked it "doubtful" in my "List" for both New Zealand and Australia.

Salmacis.

We have a species of *Salmacis* in New Zealand, but I do not think it is *S. globator*, which is given in my "List" and in the "Index." Specimens are in the Otago Museum from Stewart Island, and one denuded test is in the Colonial Museum. I believe it belongs to Bell's *S. alexandri* ("Alert" Report, p. 118), which is a very variable form, and occurs freely in Port Jackson (Catl. Ech. Aust. Mus. (1891), p. 50).

Phyllacanthus dubia.

A specimen of *Phyllacanthus*, which I take to be *P. dubia*, was found by Mr. Haylock at the Kermadec Islands. This is an Indo-Pacific species, having been found also in New Caledonia, North Australia, the Red Sea, Zanzibar, and the Bonin Islands.